HYDRAULIC CALCULATION OF DIVERSION TUNNEL

[UPPER TRISHULI-1 HEP (216MW)]

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DOOSAN Doosan Heavy Industries & Construction

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Hydraulic Calculation of Diversion Tunnel

1 Analysis purpose

At this detail design stage of diversion works, the 20-year dry season flood standard is considered. According to the hydrological analysis illustrated in design optimization proposal (DOP) for diversion tunnel works, the corresponding design flood discharge is 208m^3/s. Overflowing of the cofferdam is considered during flood season. For the safety of headwork construction, a proper flood protection standard should be the flood flow 1367.3 m^3/s of the 5-year return period flood.

The calculation is to analyse discharge capacity of diversion tunnel in dry season, and to analyse combined discharge capacity of diversion tunnel and cofferdam in flood season.

2 Reference Documents

(1) USACE EM 1110-2-1601 Hydraulic Design of Flood Control Channels.

(2) USACE EM1110-2-1602 Hydraulic Design of Reservoir Outlet Work.

(3) USACE EM 1110-2-2901 Tunnels and Shafts in Rock.

(4) USACE EM 1110-2-2902 Conduits, Culverts, and Pipes.

(5) Chow, V.T. 1959. Open-channel Hydraulics, McGraw-Hill, New York.

(6) USACE, Hydraulic Design Criteria.

(7) Open Channel Hydraulics, A. Osman Akan, First edition 2006.

(8) Design Optimization Proposal for Diversion Tunnel Works (Rev.D),29th Nov. 2021.

(9) Annex 1: Arrangement drawing of diversion Tunnel.

(10) Annex 2: Excavation and support drawing of inlet and outlet of diversion tunnel.

(11) Annex 3: Outline drawing of inlet structure of diversion tunnel.

(12) Annex 4: Outline drawing of diversion tunnel lining.

(13) Annex 5: Embankment drawing of U/S cofferdam.

(14) Annex 6: Embankment drawing of D/S cofferdam.

3 Design criteria

During the dry season, the cofferdam is used to retain water and the diversion tunnel is used for release the river flow. During the flood season, the river water will flow through the cofferdam surface and the diversion tunnel.

Dry season (November to April): 1:20 AEP（annual exceedance probability） flood, discharge is 208m^3/s. The dry season has been selected as 6 months' period, i.e. Diversion works are designed to protect the construction pit for half the year only. When the flow discharge of the river bed is lower than 208m^3/s, the river water is discharged through the diversion tunnel, and under the protection of the cofferdam, constructions in the foundation pit are carried out in under dry condition. For flood season the protection criteria is whole year 5-year return period flood and corresponding to the discharge of 1367.3 m3/s. Construction of the foundation pit suspends at this time.

Permissible flow velocities of concrete lining in tunnel: 20m/s ~ 25m/s.

Freeboard of cofferdam: 1.0m~1.5m

Overtopping of cofferdam will be allowed under 1:5 AEP flood conditions.

Maximum height of overtopping: 8.5m.

Permissible flow velocities of steel cages or gabion: 7m/s~9m/s.

4 Common Formulas and data for Hydraulic Calculation

The diversion tunnel is located on right bank of the River, 1:20AEP dry season flood diversion standard shall be used, and the flow is 208 m^3/s. The protection criteria is 1:5AEP in flood season corresponding flow is 1367.3 m^3/s. And this project set on diversion tunnel with D shape section with cross section 5.0m×5.0m. The length of diversion tunnel is 413.042 m. The inlet invert elevation is EL.1244.5 m. The outlet invert elevation is EL.1231.0 m. The detail profiles refer to the Annex 1~ Annex 6.

4.1 Discharge capacity of Diversion Tunnels

If the downstream water level is higher than the outlet tunnel crown elevation, water flow is of pressurized flow; otherwise, H/D is used to determine the flow regime.

If H/D＜1.2, free flow;

1.5>H/D>1.2, transition flow;

H/D>1.5, pressurized flow;

Where:

H—upstream water head from tunnel inlet invert, m;

D—tunnel height, m.

4.1.1 Free flow hydraulic calculation

Discharge capacity is calculated as per free flow from formula:

$$Q = m\sigma_m b\sqrt{2g}H_0^{1.5} \quad (4\text{-}1)$$

Where:

b—clear width of tunnel or weir width, m;

σ_m—submergence coefficient;

m— discharge coefficient, generally take 0.34;

H_0—The elevation difference between the upstream water surface and tunnel inlet invert, m;

g – Acceleration of gravity, g=9.81m/s^2.

4.1.2 Pressurized flow hydraulic calculation

(1) Calculation Formula

Calculation formula of pressurized flow:

$$Q = CA\sqrt{2gH} \quad (4\text{-}2)$$

Where,

Q— discharge, m^3/s;

C— discharge coefficient;

A— tunnel outlet cross-section area, m^2;

H— water head, H=upstream water level- downstream water level, m;

g— gravitational acceleration, g=9.81 m/s^2.

(2) Calculate discharge coefficient C from formula:

$$C=\frac{1}{\sqrt{1+\sum\xi_i(\frac{A}{A_i})^2+\sum\frac{2gl_i}{C_i^2R_i}(\frac{A}{A_i})^2}} \quad (4\text{-}3)$$

Where,

A —— tunnel outlet cross-section area;

ξ_i ——additional head loss coefficient, tunnel section i, A_i is cross-section area;

l_i ——length of tunnel section i, corresponding cross-section area, hydraulic radius and Chezy coefficient are A_i, R_i and C_i.

Calculate Chezy coefficient C_i from formula:

$$C_i=\frac{1}{n_i}R_i^{1/6} \quad (4\text{-}4)$$

$$R_i=\frac{A_i}{\chi_i} \quad (4\text{-}5)$$

Where,

R_i ——Tunnel section hydraulic radius, m;

n_i ——Tunnel roughness, for concrete liner;

χ_i ——Tunnel wetted perimeter

For concrete liner, roughness n is 0.014.

(3) Calculation of water loss

a) Friction head loss

Friction head loss coefficient is calculated from formula:

$$\xi = \frac{2g}{c^2}\frac{L}{R} \tag{4-6}$$

Definitions refer to formula.

$$\sum \frac{2gl_i}{C_i^2 R_i}\left(\frac{A}{A_i}\right)^2 \tag{4-7}$$

Calculation of friction head loss is shown in table 4.1, and calculation of additional head losses from inlet to outlet is shown in table 4.2.

Table 4.1 Calculation of Friction Head Loss

n	A	A_i	χ	R	C	L	$\sum \frac{2gl_i}{C_i^2 R_i}\left(\frac{A}{A_i}\right)^2$
0.014	22.84	22.84	18.12	1.26	74.237	413.04	1.17

Table 4.2 Calculation of Total Additional Loss

Additional Losses	ξ	$\frac{A}{A_i}$	$\xi i\left(\frac{A}{Ai}\right)^2$
Inlet loss coefficient	0.2	0.87	0.151
Inlet gate slot loss coefficient	0.1	0.91	0.083
Bend 1# loss coefficient	0.107	1	0.107
Bend 2# loss coefficient	0.082	1	0.082
Total additional losses $\sum \xi_i \left(\frac{A}{A_i}\right)^2$	/	/	0.424

Note:

Loss coefficient of bend is calculated from formula:

$$\xi = \left[0.131 + 0.1632\left(\frac{d}{r}\right)^{3.5}\right]\frac{\theta}{90^0}^{1/2} \quad (4\text{-}8)$$

Where,

d— tunnel width, 5.0m;

r— turning radius, bend r=50m/45m;

θ— turning angle, bend θ=60.0°/35°;

4.2 Water level and discharge relationship at outlet

The water level and discharge relationship at outlet is listed in Table 4.3.

Table 4.3 Water Level and Discharge Relationship at Outlet

Outlet water level(m)	Discharge(m^3/s)
1231.53	0.00
1232.00	3.74
1232.50	23.3
1233.00	57.9
1233.50	108
1234.00	176
1234.50	263
1235.00	367
1235.50	483
1236.00	622
1236.50	758
1237.00	920
1237.50	1100
1238.00	1280
1238.50	1480
1239.00	1730
1239.50	1920
1240.00	2160
1240.50	2430

4.3 Monthly average discharge

The monthly average discharge is listed in Table 4.4.

Table 4.4 Monthly average discharge

Month	Discharge(m^3/s)
Jan.	43.5
Feb.	38.5
Mar.	38.4
Apr.	48.1
May	87.2
Jun.	227
Jul.	479
Aug.	546
Sep.	363
Oct.	159
Nov.	79.7
Dec.	54.7
Average	182

5 Discharge capacity

According to the DOP of diversion works, the u/s cofferdam have 3 kinds operation modes. And type 1: the design flood condition is 208 m^3/s (20-year return period) in dry season;

type 2: the forecast flood condition is not more than 258 m^3/s in dry season, the corresponding water level of U/S cofferdam is at 1252.50m. The water level in front of the U/S cofferdam has reached the warning level in dry season. When the estimated flow discharge of the riverbed is greater than 258 m^3/s, combined with hydrological forecasts, personnel and equipment in the riverbed foundation pit should be evacuated out and the sub-cofferdam be removed.

type 3: the combined discharge condition. the protection criteria (whole year 5-year return period) withstand flood of diversion works is 1367.3 m^3/s. after the sub-cofferdam is removed in the flood season, when the riverbed flow is greater than 100 m^3/s, the river water

is discharged through the diversion tunnel on the right bank and the overflowing cofferdam.

5.1 Design flood condition in dry season

According to the DOP of diversion works, the design flood criteria in the dry season is 20-year return period flood corresponding to the discharge of 208 m^3/s occurs.

After pressurized flow hydraulic calculation, discharge coefficient C equals to 0.6136, the diversion tunnel discharge capacity refer to Table 5.1.

Table 5.1 Type 1 Discharge Capacity of Diversion Tunnel

Discharge (m^3/s)	Inlet water level(m)	Flow regime	Flow velocity of outlet (m/s)
20.00	1246.42	free flow	2.83
40.00	1247.55	free flow	4.59
60.00	1248.49	free flow	5.94
80.00	1249.33	free flow	7.21
100.00	1250.11	free flow	8.26
110.61	*1250.50*	*transition point*	*8.78*
120.00	1250.60	transition flow	9.27
140.00	1250.71	transition flow	10.24
160.00	1250.88	transition flow	11.10
180.00	1251.08	transition flow	11.91
200.00	1251.30	transition flow	12.75
208.00	1251.39	transition flow	13.08

5.2 Forecast flood condition

According to the DOP of diversion works, the forecast warning flood is 258 m^3/s in dry season. After pressurized flow hydraulic calculation, discharge coefficient C equals to 0.6136, the diversion tunnel discharge capacity refer to Table 5.2.

Table 5.2 Type 2 Discharge Capacity of Diversion Tunnel

Discharge (m^3/s)	Inlet water level(m)	Flow regime	Flow velocity of outlet (m/s)

Discharge (m^3/s)	Inlet water level(m)	Flow regime	Flow velocity of outlet (m/s)
20.00	1246.42	free flow	2.83
40.00	1247.55	free flow	4.59
60.00	1248.49	free flow	5.94
80.00	1249.33	free flow	7.21
100.00	1250.11	free flow	8.26
110.61	***1250.50***	***transition point***	***8.78***
120.00	1250.60	transition flow	9.27
140.00	1250.71	transition flow	10.24
160.00	1250.88	transition flow	11.10
180.00	1251.08	transition flow	11.91
200.00	1251.30	transition flow	12.75
220.00	1251.54	transition flow	13.53
240.00	1251.80	transition flow	14.25
253.98	***1252.00***	***transition point***	***14.73***
258.00	1252.54	pressurized flow	14.87

5.3 Combined discharge condition

According to the DOP of diversion works, in the flood season, the sub-cofferdam is removed, when the river bed flow is greater than 100 m^3/s, the river water is discharged through the diversion tunnel and overflowing cofferdam. After pressurized flow hydraulic calculation, discharge coefficient C equals to 0.6136, the diversion tunnel discharge capacity refer to Table 5.3.

Table 5.3 Type 3 Discharge Capacity of Diversion Tunnel

Discharge of diversion tunnel m^3/s	Inlet water level Of D/T(m)	Flow regime	Discharge of U/S cofferdam m^3/s	Total Discharge m^3/s
100.04	1250.11	free flow	1.46	101.50
109.98	1250.48	free flow	13.02	123.00
110.61	***1250.50***	***transition point***	***13.99***	***124.60***
120.02	1250.56	transition flow	16.68	136.70
130.01	1250.63	transition flow	19.99	150.00
140.00	1250.71	transition flow	23.80	163.80

Discharge of diversion tunnel m^3/s	Inlet water level Of D/T(m)	Flow regime	Discharge of U/S cofferdam m^3/s	Total Discharge m^3/s
150.00	1250.80	transition flow	28.16	178.20
160.03	1250.88	transition flow	33.07	193.10
170.02	1250.98	transition flow	38.58	208.60
180.03	1251.08	transition flow	44.77	224.80
190.05	1251.19	transition flow	51.65	241.70
200.04	1251.30	transition flow	59.26	259.30
210.05	1251.42	transition flow	67.65	277.70
220.04	1251.54	transition flow	76.86	296.90
230.04	1251.67	transition flow	86.96	317.00
240.04	1251.80	transition flow	97.96	338.00
250.00	1251.94	transition flow	109.90	359.90
253.98	***1252.00***	***transition point***	***115.22***	***369.20***
258.00	1252.54	pressurized flow	165.80	423.80
260.02	1252.81	pressurized flow	193.98	454.00
265.00	1253.49	pressurized flow	272.00	537.00
270.00	1255.81	pressurized flow	610.00	880.00
275.01	1257.30	pressurized flow	882.49	1157.50
278.05	***1258.30***	***pressurized flow***	***1089.25***	***1367.30***
280.01	1258.91	pressurized flow	1223.99	1504.00
284.20	***1260.20***	***pressurized flow***	***1543.00***	***1827.20***
285.01	1260.59	pressurized flow	1632.99	1918.00

5.4 Conclusion of discharge capacity of D/T

According to the above different operating conditions, the discharge capacity is calculated deeply. From what has been discussed above, whether it is dry season or flood season, the diversion tunnel discharge capacity refers to Table 5.4.

Table 5.4 Discharge Capacity of Diversion Tunnel

Discharge of diversion tunnel m^3/s	Inlet water level Of D/T(m)	Flow regime
20.00	1246.42	free flow
40.00	1247.55	free flow

Discharge of diversion tunnel m^3/s	Inlet water level Of D/T(m)	Flow regime
60.00	1248.49	free flow
80.00	1249.33	free flow
100.04	1250.11	free flow
110.61	***1250.50***	***transition point***
120.02	1250.56	transition flow
140.00	1250.71	transition flow
160.03	1250.88	transition flow
180.03	1251.08	transition flow
200.04	1251.30	transition flow
220.04	1251.54	transition flow
240.04	1251.80	transition flow
253.98	***1252.00***	***transition point***
260.02	1252.81	pressurized flow
270.00	1255.81	pressurized flow
280.01	1258.91	pressurized flow

6 Flow profiles in the tunnel

6.1 Calculating theory

For the gradually-varied flow profiles, one form of the gradually-varied flow equation as:

$$\frac{dE_s}{ds} = i - J$$

i —energy slope, represents the slope of the energy grade line.

J —friction slope.

s —the displacement in the flow direction.

Es —the specific energy, is defined as the energy head relative to the channel bottom.

For rectangular channels, it is convenient to work with the unit width of the channel. Defining q=Q/b=discharge per unit width, the specific energy can be written as

$$E = h + \frac{\alpha q^2}{2gh^2}$$

Where

α —energy correction coefficient, for regular channels often set equal to 1.0 for simplicity.

For critical flow in rectangular channels, a simple relationship between the critical depth h_k, and critical flow specific energy, E_k, as

$$h_k = \sqrt[3]{\frac{\alpha q^2}{g}}$$

In practice, we apply a finite difference approach to calculate the gradually-varied flow profiles. In this approach, the channel is divided into short reaches and computations are carried out from one end of the reach to the other.

In the standard step method, the flow depths are calculated at specified locations. As in the direct step method, we know the flow depth and velocity at one end of a channel reach.

Assuming depth of section p is h_p, and the spacing Δs_p between two section is known. We can determine the h_{p+1} of section p+1, by equation iteratively.

$$h_p + \frac{\alpha Q^2}{2gA_p^2} \pm \Delta s_p \left(i - \frac{Q^2 n^2}{2A_p^2 R_p^{4/3}} \right) = h_{p+1} + \frac{\alpha Q^2}{2gA_{p+1}^2} \pm \Delta s_p \left(i - \frac{Q^2 n^2}{2A_{p+1}^2 R_{p+1}^{4/3}} \right)$$

Where, the p=1,2,3, ……

Q— discharge, m^3/s;

A— tunnel outlet cross-section area, m^2;

h— water depth, m;

g— gravitational acceleration, g=9.81 m/s^2;

R— Tunnel section hydraulic radius, m;

n— Tunnel roughness.

6.2 Water surface profile calculating

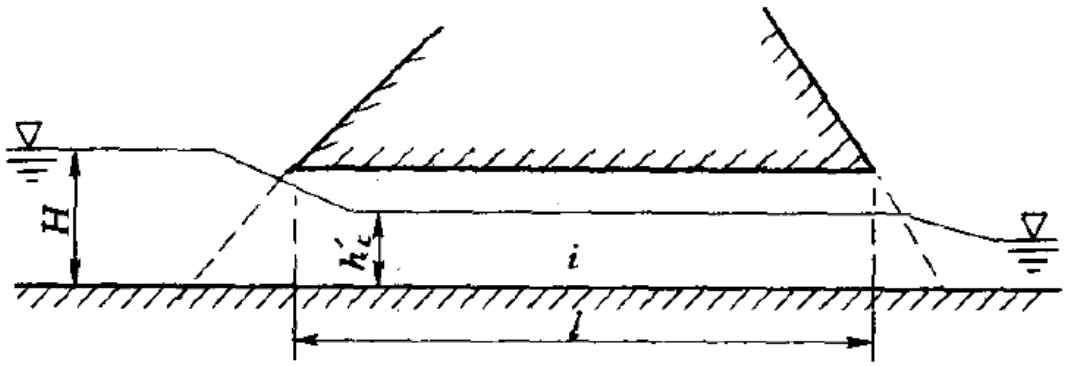
According to the discharge capacity of D/T, the calculation of water surface profiles are applied to the critical discharge flow 110.61m^3/s (free flow), 208m^3/s (AEP 1:20 dry season), 278.05m^3/s (pressurized point).

(1) Critical discharge flow 110.61 m^3/s

For the free flow, the discharge flow calculation is in line with open channel. According to energy equation, the basic parameters of discharge flow 110.61 m^3/s are as follows.

Table 6.1 Basic parameters of discharge flow 110.61 m^3/s condition

D/T height (m)	Invert elevation (m)	Head water Elevation (m)	D/T invert slop （%） i	Discharge of D/T (m^3/s)	Critical slop(%) i_k	D/S water level m
5.0	1244.50	1250.50	3.32	110.61	0.4	1233.52



Because of the D/T invert slop i > ik, the discharge capacity is not affected by length.

So the critical water depth of supercritical flow can be determined.

Table 6.2 Result of discharge flow 110.61 m^3/s condition

Item	Critical water depth (m)	Outlet water depth (m)	Outlet total water head (m)
Result export	3.75	1.8	10.22

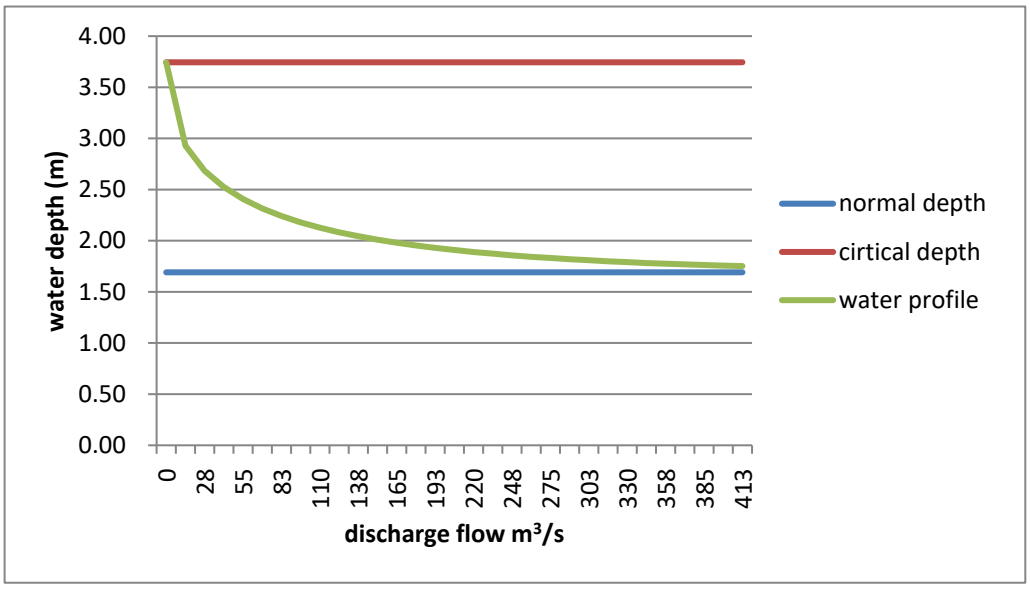
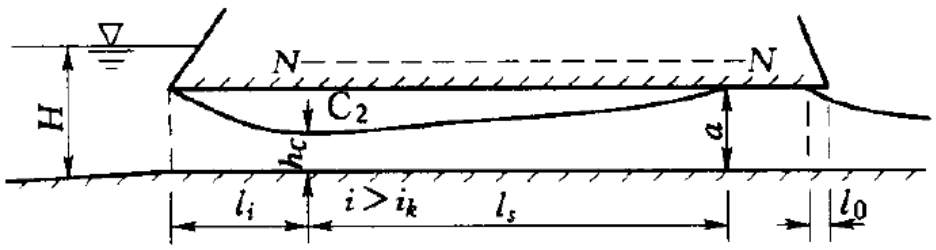


Figure 6.1 Water profile of discharge flow 110.61 m³/s

(2) Critical discharge flow 208 m³/s



For the transition flow, the basic parameters are as follows.

Table 6.3 Basic parameters of discharge flow 208 m³/s condition

D/T height	Invert elevation	Head	D/T invert	Discharge	Critical	D/S water

(m)	(m)	water elevation(m)	slop （%） i	of D/T (m^3/s)	slop(%) i_k	level m
5.0	1244.50	1251.30	3.32	208	0.49	1234.18

Because of the D/T invert slop $i > i_k$, the discharge capacity is not affected by length.

So the critical water depth of supercritical flow can be determined.

Table 6.4 Result of discharge flow 208 m^3/s condition

Item	Critical water depth hc (m)	l_i (m)	l_0 (m)	ls (m)	Critical length l_{ks} (m)	Outlet area (m^2)	Outlet velocity (m/s)
Result export	2.9	7	2.5	303	312.5	22.8	8.8

Because of the critical length l_{ks} < Length of D/T, this flow regime should be avoided.

According to the monthly average discharge, in the dry season the mean monthly flows are all less than 110.61 m^3/s, and all are free flow.

The discharge flow of 110.61~253.98 m^3/s condition is rather transient, so there is little influence on the operation of tunnel safely. The outlet total water head (E_0) is 9.1m.

(3) Critical discharge flow 278.05 m^3/s

For the pressurized flow, the basic parameters are as follows.

Table 6.5 Basic parameters of discharge flow 278.05 m^3/s condition

D/T height (m)	Invert elevation (m)	Head water elevation(m)	D/T invert slop （%） i	Discharge of D/T (m^3/s)	Critical slop(%) i_k	D/S water level

						m
5.0	1244.50	1258.30	3.32	278.05	0.56	1238.20

Table 6.6 Result of discharge flow 278.05 m^3/s condition

Item	Outlet invert elevation (m)	Additional head loss coefficient	Friction head loss coefficient	Outlet section area (m^2)	Outlet velocity (m/s)
Result export	1231	0.49	1.17	22.8	12.2

Considering the head loss, the outlet total water head (E_0) is 14.1m.

6.3 Hydraulic jumping

The D/S slab outside of D/T tunnel is concrete material, the cross section width of the concrete slab is 9m~16m, and the open channel is gradually varied. For ease of calculation, the calculation model is simplified to rectangular open channel.

We can determine the flow depth h', at the super critical depth location by writing the energy equation between this section and a section just at the outlet of the tunnel. Neglecting the energy loss between the two sections, we can write the supercritical depth.

$$E_0 = h' + \frac{q^2}{2g\varphi^2 h'^2}$$

where,

ϕ—velocity coefficient, take as 0.95.

h'—supercritical depth, m.

q—discharge per unit width, $m^3/s/m$.

the conjugate depth h'', the two depth h' and h'' should satisfy the hydraulic jump equation, rewritten here as

$$h'' = \frac{h'}{2}\left(\sqrt{1 + 8Fr^2} - 1\right)$$

where Fr= Froude number, for a rectangular section with constant width, we can evaluate the

Froude number as

$$Fr = q/\left(h'\sqrt{gh'}\right)$$

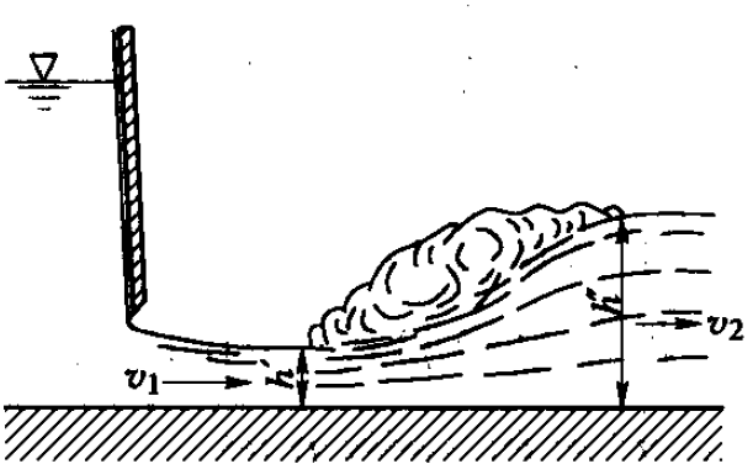


Table 6.7 Hydraulic jumping parameters of different discharges

Discharge (m^3/s)	110.61	208	278.05
Single discharge or combined	Single	single	combined
Outlet E_0 (m)	10.22	9.1	14.1
Open channel average width (m)	12.5	12.5	12.5
Supercritical depth h'(m)	1.8	2.9	2.25
Conjugate depth h''(m)	2.5	3.19	5.7
Critical depth of open channel(m)	2.0	3.05	3.7
D/S water elevation (m)	1233.52	1234.18	1238.20
D/S water depth (m)	2.52	3.18	7.2
Velocity (m/s)	*3.5*	*5.3*	*3.9*

Length of jumping (m)	3.6	2.0	23.6
Type of hydraulic jumping	Critical jumping	Critical jumping	Submerged jumping

From the calculation of jumping, the outlet open channel already has paved with concrete slab and gabion. So under the design flood condition, the protection measures of tunnel outlet are feasible.

7 Characteristic water levels

7.1 Diversion during dry season

During dry season (November to April), the water discharges from diversion tunnel. The flow (1:20AEP dry season diversion standard) is 208m^3/s, and the corresponding outlet water level is 1234.18m. After hydraulic calculation, the inlet water level is 1251.5m.

7.2 Diversion during flood season

During flood season (May to October), the water discharges from upstream cofferdam and tunnel. The flow (1:5AEP and 1:20AEP flood season diversion standard) is 1367.3m^3/s and 1827.2 m^3/s, The diversion tunnel is pressurized flow and the cofferdam is free flow. The combined discharge calculation is shown in table 7.1 and table 7.2.

Table 7.1 Combined discharge calculation (Total flow-1367.3m^3/s)

Diversion tunnel	Inlet bottom Elevation (m)	Outlet bottom Elevation (m)	Upstream water level (m)	Downstream water level (m)	Discharge coefficient	Flow (m^3/s)
	1244.5	1231	1258.3	1238.2	0.6136	278.05

Cofferdam	Crest Elevation (m)	Upstream water level (m)	Average Width (m)	submergence coefficient	Discharge coefficient	Average flow velocity of cofferdam crest (m^3/s)	Contracted water depth(m) of cofferdam foot downstream(EL.1244.0)	Maximum flow Velocity (m^3/s) of cofferdam foot downstream(1244.0)	Flow (m^3/s)
	1250.0	1258.3	30.26	1.0	0.34	6.76	2.65	13.6	1089.25

Table 7.2 Combined discharge calculation (Total flow-1827.2m^3/s)

Diversion tunnel	Inlet bottom Elevation (m)	Outlet bottom Elevation (m)	Upstream water level (m)	Downstream water level (m)	Discharge coefficient	Flow (m^3/s)
	1244.5	1231	1260.2	1239.3	0.6136	284.2

Cofferdam	Crest Elevation (m)	Upstream water level (m)	Average Width (m)	submergence coefficient	Discharge coefficient	Average flow velocity of cofferdam crest (m^3/s)	Contracted water depth (m) of cofferdam foot downstream(EL.1244.0)	Maximum flow Velocity(m/s) of cofferdam foot downstream(1244.0)	Flow (m^3/s)
	1250.0	1260.2	31.3	1.0	0.34	7.45	3.46	14.24	1543.0

8 Conclusions

During dry season, the water discharges from diversion tunnel. Discharge of diversion tunnel is 208 m^3/s. The inlet water level is 1251.5m. During flood season(1:5AEP), the water discharges from upstream cofferdam and diversion tunnel, discharge of cofferdam and diversion tunnel is 1089.25m^3/s and 278.05m^3/s. The inlet water level is 1258.3m. During flood season(1:20AEP), the water discharges from upstream cofferdam and diversion tunnel, discharge of cofferdam and diversion tunnel is 1543.0m^3/s and 284.2m^3/s. The inlet water level is 1260.2m.